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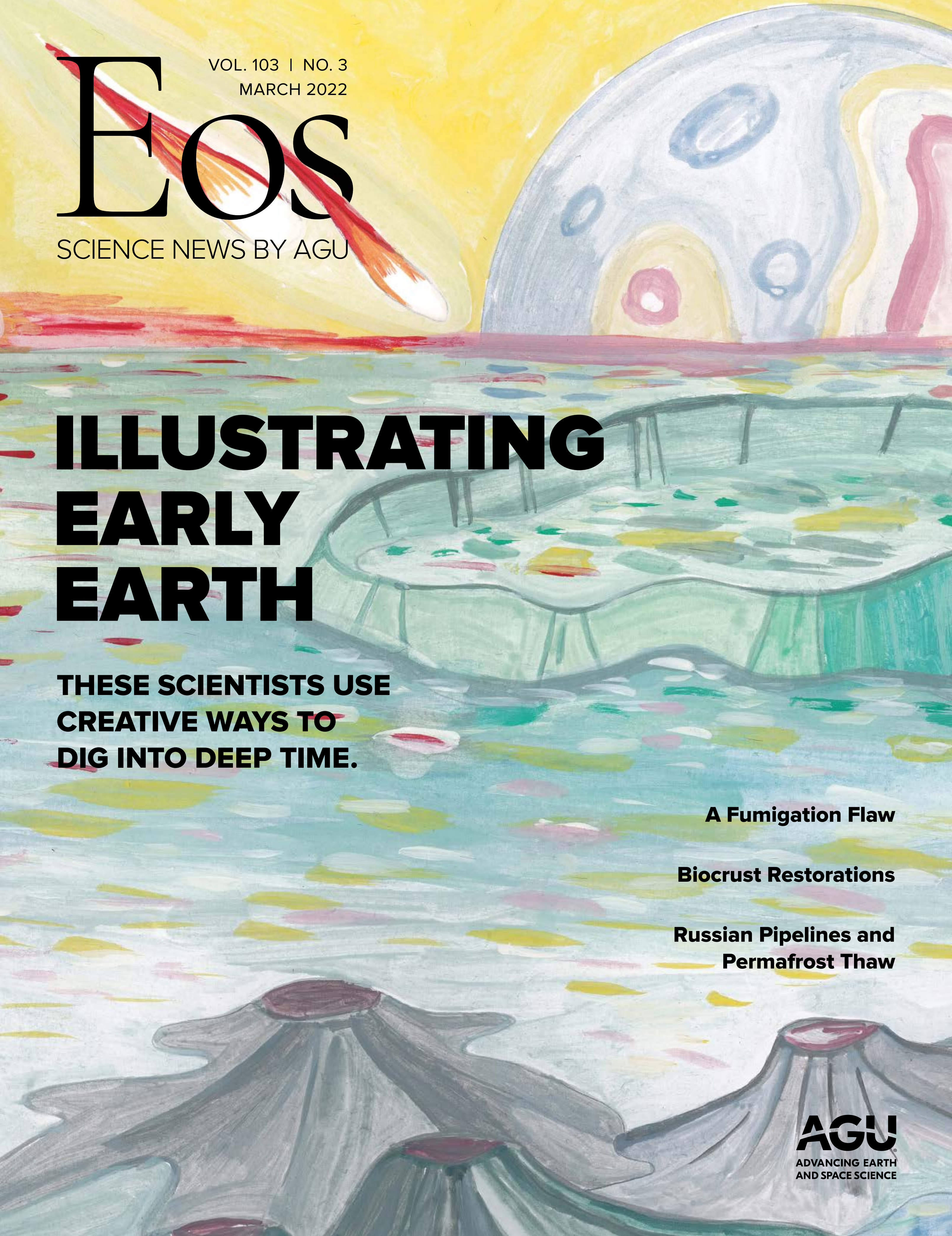

ILLUSTRATING EARLY EARTH

THESE SCIENTISTS USE CREATIVE WAYS TO DIG INTO DEEP TIME.

A Fumigation Flaw

Biocrust Restorations

Russian Pipelines and Permafrost Thaw

AGU
ADVANCING EARTH AND SPACE SCIENCE

The Perspective from Space Unlocks the Amazon Water Cycle

The Amazon River and its tributaries, as seen from the International Space Station, have intricate and complex hydrology. Credit: Alexander Gerst, CC-BY-SA 2. (bit.ly/ccbysa2-0)

The Amazon basin is the world's largest river basin, with intricate and complex hydrology. It stretches across seven nations and feeds four of the 10 largest rivers in the world. The basin encompasses dense tropical forests, extensive floodplains, and interconnected wetlands. The region also receives a lot of rain—approximately 2,200 millimeters (86 inches) per year. Gaining a better understanding of Amazon hydrology is essential, especially in light of the ongoing environmental changes across the basin, from increasing floods, droughts, dam building, and deforestation.

Given the size and complexity of the ecosystem, scientists have used satellite technology to turn the Amazon into the world's premier remote sensing laboratory for hydrological and water cycle science. And more exciting science is on the horizon—NASA soon plans to launch two dedicated hydrology satellites: the Surface Water and Ocean Topography (SWOT) mission and the NASA-ISRO SAR (NISAR) mission.

In advance of the upcoming remote sensing missions, *Fassoni-Andrade et al.* recently published a comprehensive review of the basin's hydrology. An international team of more than 20 scientists compiled the study, which looks at 3 decades of work. The assessment evaluates precipitation, evapotranspiration, surface water, aquatic ecosystems, environmental changes, and more through the lens of remote sensing. The review provides a holistic view of the Amazon's water cycle while laying out challenges and knowledge gaps for future research in the region.

The authors treat each topic as a subreview—for example, looking at precipitation, they discuss how infrared and microwave sensors monitor rainfall and describe the algorithms that process the data. They then report on successful remote sensing applications, such as how one project used satellite data to delineate the beginning and the end of the Amazonian wet season. Last, the authors outline some challenges of measuring precipitation through remote sensing, including those related to the asymmetry of satellite readings and weather processes on the ground. They apply a similar structure to the other themes evaluated in the review.

According to the authors, their study serves as a model for synthesizing large-scale hydrological information about other river basins. While the knowledge reviewed in the paper needs to be translated to water management and environmental governance, the authors hope the study will lead to an integrated monitoring and research agenda across the basin. (*Reviews of Geophysics*, https://doi.org/10.1029/2020RG000728, 2021) **—Aaron Sidder,** *Science Writer*

Stratospheric Balloons Listen In on Ground Activity

Earthquakes, volcanic eruptions, and even severe weather events produce a medley of low-frequency infrasound waves below the range of human hearing. Researchers can investigate these sounds to gain a deeper understanding of our planet. In addition to natural events, infrasound sensors can pick up events caused by human activity, from city noise to nuclear explosions.

As part of a larger research team, *Bowman and Krishnamoorthy* detonated a canister located about 50 meters below the ground that was filled with an explosive equivalent to 10 tons of 2,4,6-trinitrotoluene (TNT). A network of instruments on the ground—including accelerometers, seismometers, and microbarometers—recorded ground shaking and pressure waves from the explosion. Ground sensors picked up the pressure waves 12 kilometers from the blast, but another array about 46 kilometers away heard nothing.

By contrast, the researchers report, microbarometers carried by solar-powered hot-air balloons in the lower stratosphere, more than 20 kilometers above Earth's surface, detected infrasound signals from the buried chemical explosion. The researchers propose that the balloon-borne microbarometers detected a strong signal because the troposphere directs sound upward. In addition, the sensors would not have been affected by background noise and sound-scattering features on the ground.

The new study supports further use of balloon-borne microbarometers for investigating geophysical activity and monitoring explosions on Earth. The results also support mission concepts proposing to use balloons to explore Venus and investigate volcanic activity and venusquakes via infrasound. (*Geophysical Research Letters*, https://doi.org/10.1029/2021GL094861, 2021) **—Jack Lee,** *Science Writer*